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Technical and Functional Requirements

Requirements (Assumptions) for the OU 7-13/14 In Situ Grouting Project

Idaho National Engineering and Environmental Laboratory

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REQUIREMENTS (ASSUMPTIONS) FOR THE OU 7-13/14 IN SITU GROUTING PROJECT	Identifier: TFR-280 Revision: 0 Page: 1 of 17

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1. INTRODUCTION

1.1 Facility Modification Identification

This technical and functional requirement (T&FR) document supports the acquisition of in situ grouting services for the Subsurface Disposal Area (SDA) of the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering and Environmental Laboratory (INEEL).

1.2 Limitations of the T&FRs

This document collects the assumptions derived from the engineering design studies for the OU 7-13/14 In Situ Grouting Project and from other sources. These studies span preconceptual design, conceptual design, and detailed design.

1.3 Ownership of the T&FRs

The project engineer assigned to the OU 7-13/14 In Situ Grouting Project owns this document and is responsible for any changes.

2. OVERVIEW

This document collects the assumptions derived from the engineering design studies and from other sources for the OU 7-13/14 In Situ Grouting Project. This document was initiated, prepared, reviewed, and approved using MCP-9185, "Technical and Functional Requirements." MCP-9185, Appendix B, "T&FR Outline," was used as a guide and modified as needed to meet project specifics. This document is controlled using MCP-135, "Creating, Modifying, and Canceling Procedures and Other DMCS-Controlled Documents."

2.1 Facility, Structure, System, Component Functions

The systems shall be capable of providing grout and injecting it into the ground at specified locations.

2.2 Facility, Structure, System, Component Classification

The system and components shall be categorized as consumer grade.

2.3 Operational Overview

Grout is typically pumped into the waste zone using high pressure. Injection tools are inserted into the waste zone in a tightly spaced pattern. Grouting is accomplished with minimal displacement of contaminants and debris or ground heaving. Containers of waste are breached and filled from the inside with grout. This method produces interlocking columns of grout extending from the underburden soil up through the waste, terminating subsurface in the overburden.

The interlocking columns cure into a solid monolith with no discernable edges between columns (*Evaluation of In Situ Grouting for Operable Unit 7-13/14*, INEEL/EXT-01-00278, Rev. 0, December 2002).

3. ASSUMPTIONS AND BASES

3.1 Fire Protection Subsystem

A fire hazards analysis will be prepared to identify and gain acceptance of the fire protection requirements for the project. (00200)

Basis – EDF-5054

3.2 Grout Delivery Subsystem

Grout will be delivered to the grout receiving hopper by ready mix-style trucks. (00201)

Basis – EDF-5102

The high-pressure system maximum operating pressure will be 8,000 pounds per square inch, which is 80 percent of the maximum allowable working pressure (10,000 pounds per square inch) of the high-pressure system components. (00202)

Basis – EDF-5102

The high-pressure grout pump will be designed to supply grout at 8,000 pounds per square inch (552 bar) measured at the pump outlet, which is the location of the maximum operating pressure. (00203)

Basis – EDF-5102

The average grout column height to be used for design is 13 feet, equating to an average 15-foot depth to bedrock (from the trench depth map minus 2 feet of overburden [from EDF-4013]). (00204)

Basis – EDF-5102

Grout volume to be injected is 13.6 gallons per foot of column height (INEEL/EXT-02-00233 Section 5.4 from grouting 12 holes). (00205)

Basis – EDF-5102

The design production rate will be one column (13 linear feet) per 3.5 minutes of grouting using three jets in the drill string bit. (00206)

Basis – EDF-5102

The pump must be capable of supplying 5 gallons per minute (191 liters per minute) based on the capability of grouting 13 linear feet of waste in 3.5 minutes. (00207)

Basis – EDF-5102

The operational process of grouting will be refined during startup testing at the cold test pit south. (00208)

Basis – EDF-5102

3.3 Grout Injection Subsystem

Grouting campaigns will begin in 2005 and end in 2010, with decontamination and decommissioning occurring in 2011. (00209)

Basis – EDF-5153

Conceptual design cost uncertainties are plus or minus 20 percent. (00210)

Basis – EDF-5153

Trace alpha, beta, and gamma contamination is present within 2 feet of the surface of the SDA. (00211)

Basis – EDF-5153

Nominal waste zone starts 3 feet below the surface of the SDA. (00212)

Basis – EDF-5153

3.4 Grout Selection Subsystem

Foundation grout will be supplied by a subcontractor and will be Portland cement based. (00213)

Basis – EDF-5146

Contaminant control grout will be supplied by a subcontractor and will be Portland cement based. (00214)

Basis – EDF-5146

3.5 Grout Storage and Mixing Subsystem

Dry bulk density of sand is 100 pounds per cubic foot. (00215)

Basis - EDF 5135

Dry bulk density of cement is 94 pounds per cubic foot. (00216)

Basis - EDF 5135

Dry bulk density of ground blast furnace slag is 85 pounds per cubic foot. (00217)

Basis - EDF 5135

Semi trucks with trainers (northwest doubles) have a payload weight of 64,000 pounds. (00218)

Basis - EDF 5135

Unloading facilities will be capable of unloading sand and a powder commodity simultaneously. (00219)

Basis - EDF 5135

Silos will de sized to store a two-week supply of dry components. (00220)

3.6 Foundation Grouting Subsystem

The surface barrier will cover the entire SDA. (00221)

Basis - EDF-5028

Borrow sources for the various layers of the surface barrier were not finalized at the time of this document. (00222)

Basis – EDF-5028

The soil cover will crown along an approximately east-west SDA centerline. (00223)

Basis – EDF-5028

The existing overburden soil depth varies from 2 to 9 feet over the SDA. (00224)

Basis – EDF-5028

Each grout column is assumed to be placed perpendicular to the existing overburden soil; have an idealized, uniform, circular cross section; and rest on a relatively unyielding substrate, such as bedrock. (00225)

Basis – EDF-5028

Each column is assumed to extend from a basalt layer (unyielding) to a point in the existing overburden. (00226)

Basis – EDF-5028

A Department of Energy performance category per DOE-STD-1021 has not yet been determined for this project. (00227)

Basis – EDF-5028

3.7 Measurement and Control Subsystem

The individual subsystems will be subcontractor-designed and -installed and operated on a subcontract basis. (00235)

Basis – EDF-4933

The data derived from field instrumentation will be wirelessly transmitted to a supervisory control and data acquisition system located in a mobile trailer outside the SDA fence. (00236)

Basis – EDF-4933

Project management will require wireless Intranet communications to be the means of maintaining online connectivity and management of the accumulated data derived from the measurement and control system. (00237)

Basis – EDF-4933

110 volt alternating current and/or 24 volt direct current power will be available for all measurement and control instrumentation. (00238)

Basis – EDF-4933

The grout ingredient storage and delivery system will be designed and installed by the subcontractor at the RWMC. (00239)

Basis – EDF-4933

The overriding concern and emphasis imposed by management upon the designers of the measurements and control system is to conceive and proceed with a design that is as practical and simple as possible, while not necessarily avoiding state of the art electronic equipment. (00240)

Basis – EDF-4933

Another prime consideration is that there must be redundancy in the system, to the extent that even a failure of the supervisory control and data acquisition system would not shut down the in situ grouting operation. (00241)

Basis – EDF-4933

Equipment and techniques will be developed to successfully contain or bound the waste that is contained in large carbon steel containers whose location is only approximately known and is of unknown orientation and depths in trenches. (00242)

Basis – EDF-4933

If the system can measure the angle of tilt from the vertical and also measure the force imposed by the diversion of the drill stem, it may be possible to consistently predict when penetration of a solid container has not been achieved. (00243)

Basis – EDF-4933

System capability to measure the instantaneous rate of flow of the grout, integrate the total volumetric flow of the grout, and approximate the volume of grout returns could lead to detection of when penetration of a large container has been achieved and a larger volume of grout has been injected into a void. (00244)

Basis – EDF-4933

All components of the measurement and control system are commercially available, of proven technology, and available off the shelf for relatively short term delivery. (00245)

Basis – EDF-4933

Measurement and control system redundancy is extremely important to allow for equipment shutdown or failure while maintaining grouting operations. (00246)

Basis – EDF-4933

3.8 Electrical Support Subsystem

Trackhoe instrumentation power source will be a separate portable generator rather than using the trackhoe direct current battery as the electrical power source. The trackhoe direct current battery can be a back up to the portable generator. (00247)

Basis – EDF-5122

Power for miscellaneous needs on the SDA in the immediate area of the trackhoe will be provided with a portable generator near the trackhoe. (00248)

Basis – EDF-5122

The 12.5 kilovolt RWMC power system will be used to provide the power needs outside the SDA rather than bringing in portable generators. (00249)

Basis – EDF-5122

3.9 Facility Support Subsystem

Inspection and/or decontamination of personnel and equipment when exiting the SDA will be required. (00250)

Basis – EDF-5144

No water or food will be allowed in the SDA. (00251)

Basis – EDF-5144

No fixed utilities exist nor will be allowed in the SDA. (00252)

Basis – EDF-5144

Delivery of all grout products will be by truck rather than by railroad. (00253)

Basis – EDF-5144

3.10 Mechanical Support Subsystem

Operations involving use of water outdoors will be performed during periods when the outdoor temperature is above freezing. (00254)

Basis – EDF-5150

Existing refueling methods and systems will be available for continued use to the project. (00255)

Basis – EDF-5150

A water source will be available at the RWMC to supply water to grouting operations without tracking water from another area of the INEEL. (00256)

Basis – EDF-5150

The existing water system at the RWMC can support a continuous water flow of 30 gallons per minute. (00257)

Basis – EDF-5150

Grouting operations will occur only during one 12-hour shift per day. (00258)

Basis – EDF-5150

3.11 Vehicle Support Subsystem

Conceptual design cost uncertainties are plus or minus 20 percent. (00259)

Basis - EDF-5162

Trace alpha, beta, and gamma emitting contamination are present within 2 feet of the surface of the SDA. (00260)

Basis - EDF-5162

Nominal waste zone starts at 3 feet below the surface of the SDA. (00261)

Basis - EDF-5162

Mobile equipment need to be wheeled or tracked vehicles, engine or motor powered, together with attached or towed equipment. (00262)

Basis - EDF-5162

3.12 Environmental, Safety, and Health Subsystem

Radiological control technicians will be available at selected points to preclude work process slowdown. (00263)

Basis – EDF-5152

Contractor-supplied personnel decontamination facilities will be available. (00264)

Basis – EDF-5152

Contractor-supplied equipment decontamination facilities will not be available. (00265)

Basis – EDF-5152

Radioactively contaminated waste materials are not anticipated for this project. (00266)

Basis – EDF-5152

3.13 Operations, Maintenance, and Logistics Subsystem

The in situ grouting technical approach baseline will be semi-remote jet grouting within a mobile containment structure as preconceptualized in a feasibility study preliminary documented safety analysis. (00267)

Basis – EDF-5155

No technology development will be associated with the in situ grouting project. Some technology application testing will be done. (00268)

Basis – EDF-5155

Cold (in nonradioactive, nonhazardous environment) demonstrations of grout equipment and procedures will be necessary. (00269)

Basis – EDF-5155

Assumptions similar to those for beryllium block grouting will be made to allow work to be accomplished in a safe, secure, cost effective, and efficient manner. (00270)

Basis – EDF-5155

Qualified personnel will operate grouting equipment. (00271)

Basis – EDF-5155

A medial cost grout material will be used after being selected and specified by the contractor. (00272)

Basis – EDF-5155

The contract should clearly define responsibilities, and, as a general, guidelines should place the subcontractor in control of routine field operations. For the RWMC beryllium block grouting subcontract (Phase 1), contractor construction forces found themselves holding up the subcontractor as they struggled to address various issues that had not been planned. Problems included:

- Responsibilities for site preparation were not specific, thus causing delays

- Ordering and scheduling delivery of grout was delayed (00295).

Basis – EDF-5155

Equipment used for a purpose other than the original design needs to have the capability of being verified by physical testing under the direction of a qualified engineer per contractor management control procedures. (00296)

Basis – EDF-5155

The jets showed a tendency to work loose during grouting. The jets should be simple and soldered in-place and the bit should be a low-cost item that can be dropped in the mud and left. The optimal design is a system with a pair of jets 180 degrees apart and at the same elevation, not one above the other. This allows for a lower rpm, which is desirable for increasing penetration. (00297)

Basis – EDF-5155

The use of cementacious grout will positively result in a faster erosion of the grout jet orifices. Erosion or plugging of the jet orifices is important to note because there must be some method of tracking the erosion or detecting the plugging of the jet orifices. If this is to be done manually, it will require continual close scrutiny, analysis, and comparison of the output pressure of the high-pressure grout pump, grout density, volume of grout injected for each hole, and volume of grout returns for each hole. If no effort is made to manually record and analyze the data, the only way to check the erosion of the orifice jets is physical inspection. This will require frequent pauses in the drilling and grout injection process to frisk the drill stem to check for plugging or erosion and decide the course of corrective action. (00298)

Basis – EDF-5155

The Phase 1 system was designed with a rupture disk set at 8,500 psi. When operating at 8,000 psi, several of the rupture disks failed. 10,500-psi rupture disks are suggested. (00299)

Basis – EDF-5155

The grout containment unit and thrust block does not allow adjustments to an increase in grout returns. The trackhoe-mounted drill can handle larger volumes of returns without any negative consequences other than having some small amounts of contamination brought near the surface. A polymer spray after approximately 2 hours of grouting will minimize this issue. Another means to remove grout returns from the work area could include a vacuum truck. (00400)

Basis – EDF-5155

Based on Phase 1 work, void ratios are likely to be much lower than originally projected. No hard data have been received, but a large fraction of the jetted wax grout returned to the surface because of an absence of void space in the soil being treated. It is speculated that the cause for the increased volume of grout returns is because of compaction of the overburden soil in years subsequent to flooding of the SDA in high-water years. (00401)

Basis – EDF-5155

Soil subsidence has occurred in rows 50 through 54 in the SDA over the past several years. These occurrences have been 150 to 175 yards from the north end. This indicates that there could be a large void in that area. Some planning needs to be done to ensure that the void is filled. (00402)

Basis – EDF-5155

Skill-of-the-craft is a definition of the inherent skills that each craft discipline is qualified to perform by virtue of their experience and training in the craft discipline. The operators need to have flexibility to make adjustments to operations parameters (e.g., pressure and step time and size) for both the high-pressure pump and the drill rig. (00403)

Basis – EDF-5155

The subcontractor should use a crane-mounted, roto-percussion sonic drill or equivalent equipment. (00404)

Basis – EDF-5155

3.14 SDA Site Conditions Subsystem

Grouting will occur during a six-month period extending from late spring to early fall. (00273)

Basis – EDF-5147

Various structures associated with vapor extraction and Accelerated Retrieval Project activities also exist in the SDA. (00172)

Basis – EDF-5147

Rain and snow are the only natural sources of water within the SDA. (00173)

Basis – EDF-5147

The existing SDA access roads are gravel and may not be accessible by all types of vehicles during the entire year. (00174)

Basis – EDF-5147

The depth of overburden varies from minimum of approximately 2 feet to 6 or more feet. (00175)

Basis – EDF-5147

The International Building Code generally limits the allowable bearing capacity of soils of this type to 1,500 pounds per square foot. (00176)

Basis – EDF-5147

An engineering analysis of the bearing capabilities could be performed to establish bearing capacity. (00177)

Basis – EDF-5147

3.15 Project Assumptions

Environmental Protection Agency National Remedy Review Board will not review this action (ICP-EXT-04-00420 Section 1.4.3.1). (00274)

The project safety authorization basis will be documented as an addendum to the RWMC safety analysis report (SAR-4) (ICP-EXT-04-00420 Section 1.4.3.2). (00275)

High-pressure systems do not represent a nuclear safety concern (safety significant or safety class), but will be addressed as an industrial safety concern. (00276)

Primary containment of contaminants brought up with the grout will be provided by the grout matrix, not the use of thrust blocks, drill stem shrouds, or containment structures (ICP-EXT-04-00420 Section 1.4.3.2). (00277)

The subcontract will be placed and the subcontractor will be able to begin in situ grouting operations in the subsurface disposal area in July 2005 (ICP-EXT-04-00420 Section 1.4.3.3). (00278)

Uranium contained in both Rocky Flats Plant transuranic and low-level waste pits and trenches is a target for in situ grouting. (00228)

Carbon 14 in activated stainless steel is not a target for grouting; a cap will provide sufficient protection. (00229)

Technetium 99 and Iodine 129 are contaminants of concern that will be targeted by in situ grouting. (00230)

Trenches 16 through 58 will be included in the in situ grouting scope. (00231)

Pits 7, 8, 13, 14, 15, and 16 will be included in the in situ grouting scope. (00232)

Soil vault rows 1 through 21 will be included in the in situ grouting scope if they contain contaminants of concern on the in situ grouting target list (technetium, iodine, uranium, excluding carbon 14). (00233)

Inventory analysis that impacts requirements needs to revisited after data quality improvements are completed within the next year. (00234)

The drill rig stick and boom may need to be stiff. (00279)

Fire hazard analysis requirements will be defined. (00280)

Decision needs to be made on working in personnel protective equipment and respirators inside the SDA, which may will be handled on a case-by-case basis. (00281)

Method of getting water to rinse and rinsate in and out of the SDA is required. (00282)

There is a need to have radiological control technicians at selected process points to preclude work process slowdown and perform radiation surveys. (00283)

Decision needs to be made on whether used trackhoes will be allowed. (00284)

Decision needs to be made between cutting off the drill stem and leaving it in the ground after each grout column is created or cleaning out the drill stem. (00285).

A grout dump and cleanout pit will be required. (00286)

A water-actuated wiper on the drill string will be required. (00287)

A bit change out box will be required. (00288)

The grout batch plant will be located south of the SDA. (00289)

The holes drilled for contamination grouting will be on a 20-inch pitch (will need to revisit this after production starts). (00290)

The contamination grout will be GMENT (will need to revisit this after testing). (00291)

No fixed grout header will be located at the SDA. (00292)

Trucks will be used to deliver the grout or grout product during the first production year. (00293)

Grout can be trucked from an off-site location or produced on site. (00294)

Engineering design files provide the bases for most of the requirements in TFR-269. The desired features in TFR-269 were the result of an early brainstorming activity where required features of each subsystem were defined. (00405)

Ongoing assessments of the risks posed by the SDA may result in scope modifications that will require a reassessment of the requirement set. (00406)

4. REFERENCES

DOE-STD-1021-93, "Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components," Change 1, U.S. Department of Energy, January 1996

EDF-4013, "Feasibility Study Technical and Functional Requirements for the OU 7-13/14 In-Situ Grouting Preliminary Documented Safety Analysis"

EDF-4933, "OU 7-13/14 In Situ Grouting Project Measurement and Control"

EDF-5028, "OU 7-13/14 In Situ Grouting Project Foundation Grouting Study"

EDF-5054, "OU 7-13/14 In Situ Grouting Project Fire Protection"

EDF-5102, "OU 7-13/14 In Situ Grouting Project Grout Delivery System"

EDF-5122, "OU 7-13/14 In Situ Grouting Project Electrical Utilities"

EDF-5135, "OU 7-13/14 In Situ Grouting Project Grout Storage and Mixing"

EDF-5144, "OU 7-13/14 In Situ Grouting Project Support Facilities"

EDF-5146, "OU 7-13/14 In Situ Grouting Project Grout Selection Basis"

EDF-5147, "OU 7-13/14 In Situ Grouting Project Subsurface Disposal Area Site Conditions"

EDF-5150, "OU 7-13/14 In Situ Grouting Project Support Systems"

EDF-5152, "OU 7-13/14 In Situ Grouting Project Environmental, Safety, and Health"

EDF-5153, "OU 7-13/14 In Situ Grouting Project Hydraulic Excavator and Drill-Injection Rig"

EDF-5155, "OU 7-13/14 In Situ Grouting Project Operations, Maintenance, and Logistics"

EDF-5162, "OU 7-13/14 In Situ Grouting Project Support Vehicles"

International Building Code – UL Referenced Standards, 2nd edition

ICP/EXT-04-00420, *Project Execution Plan for the In Situ Grouting Project*, draft document

INEEL/EXT-01-00278, *Evaluation of In Situ Grouting for Operable Unit 7-13/14*, Rev. 0, December 2002

INEEL/EXT-02-00233, *Final Results Report for In Situ Grouting Technology for Application in Buried Transuranic Waste Sites, Volume 1, Technology Description and Treatability Study Results for Operable Unit 7-13/14*, 00233, Rev. 1, August 2002

MCP-135, "Creating, Modifying, and Canceling Procedures and Other DMCS-Controlled Documents"

MCP-9185, "Technical and Functional Requirements"

TFR-269, "Requirements (Subsystem) for the OU 7-13/14 In Situ Grouting Project"